(No Model.) 3 Sheets—Sheet 1.

D. URQUHART & F. WYNNE.

SUPPLY SYSTEM FOR ELECTRIC RAILWAYS.

No. 600,101. Patented Mar. 1, 1898.

FIG. 1.

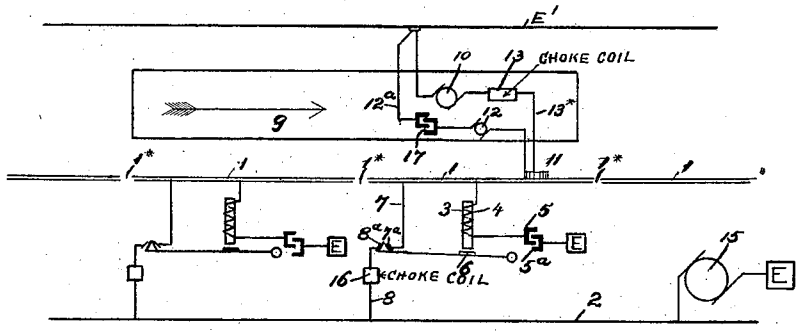


FIG. 2.

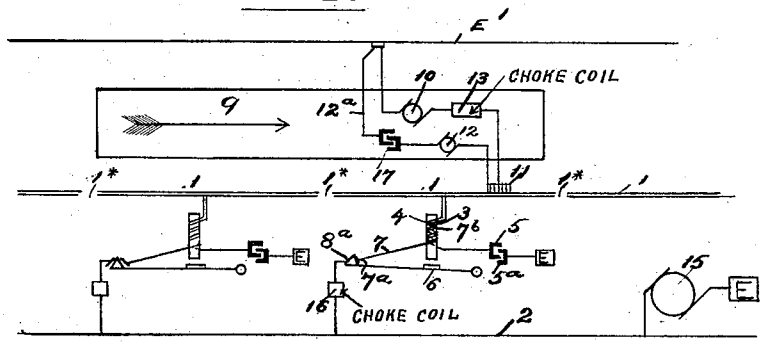
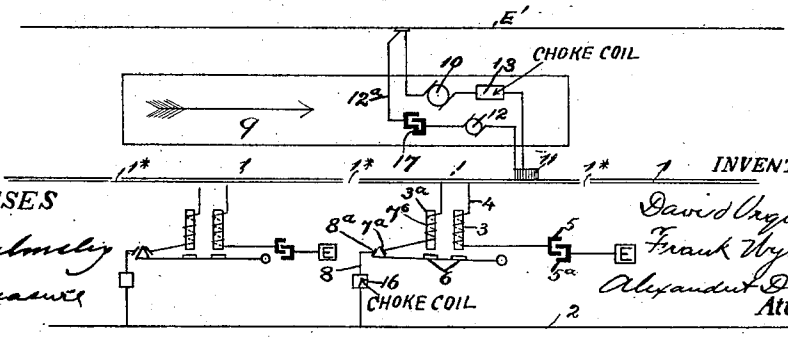


FIG. 3.



WITNESSES

G. H. Walmsley

G. W. Lamaster

INVENTORS

David Urquhart

Frank Wynne

Alexander Davis

Attorneys.

(No Model.) 3 Sheets—Sheet 2.

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FIG. 4.

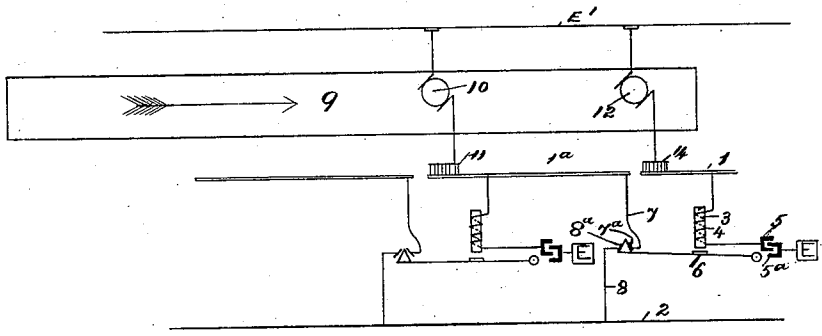


FIG. 5.

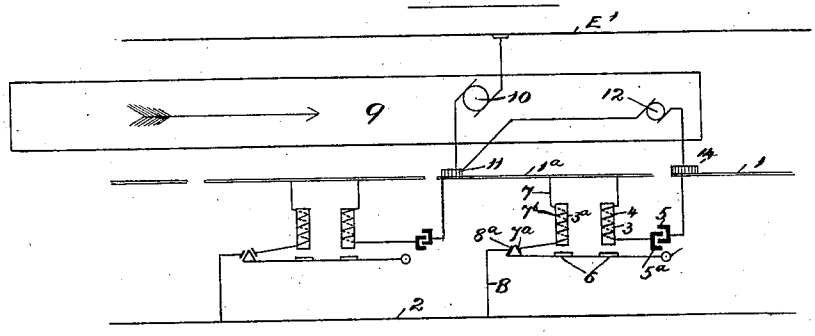
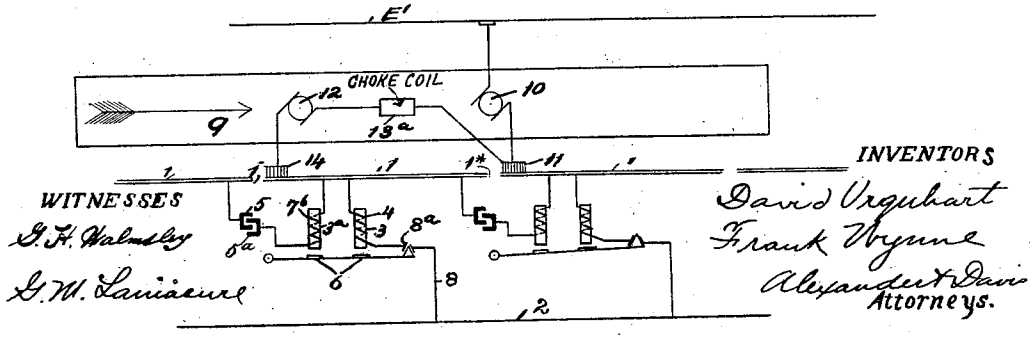


FIG. 5A.



WITNESSES

G. F. Walmsley

G. W. Lauiaeure

INVENTORS

David Urquhart

Frank Wynne

Alexander & Davis

Attorneys.

(No Model.)

3 Sheets—Sheet 3.

D. URQUHART & F. WYNNE.

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FIG. 6.

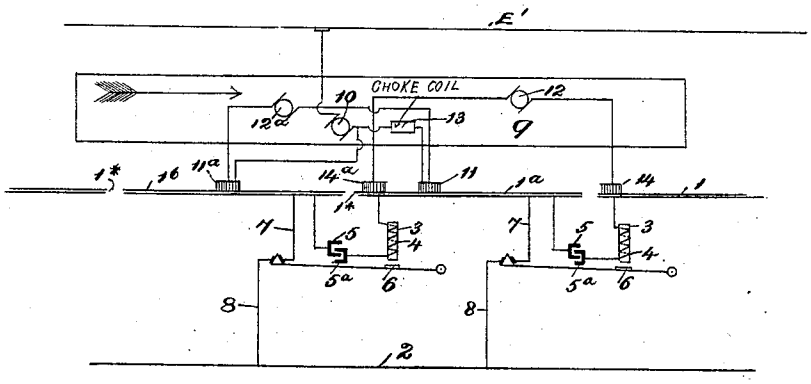


FIG. 7.

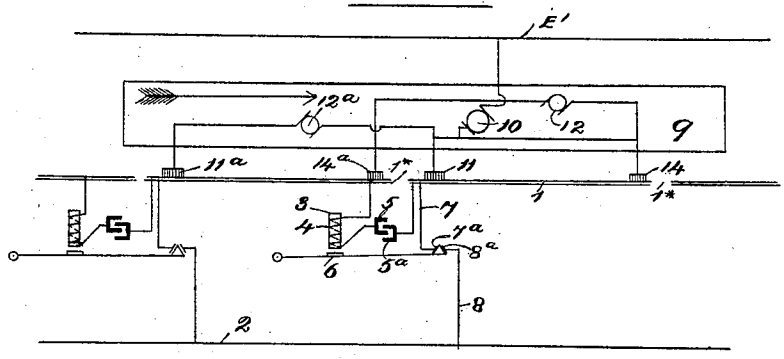
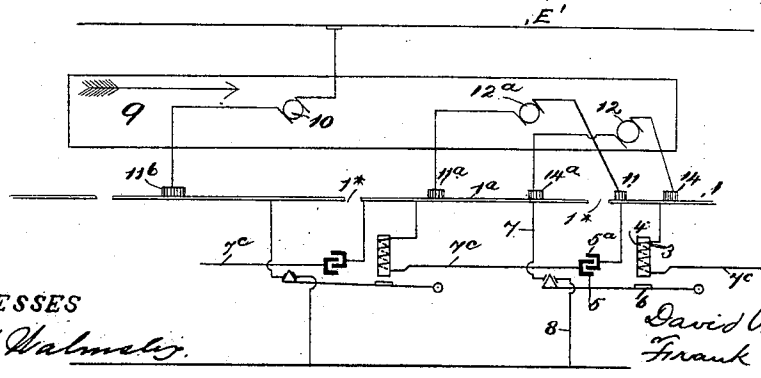


FIG. 8.



WITNESSES

G. H. Walmsley.

G. W. Lamasure

INVENTORS

David Urquhart

Frank Wynne

By Alexander & Davis their Attorneys.

UNITED STATES PATENT OFFICE.

DAVID URQUHART AND FRANK WYNNE, OF LONDON, ENGLAND.

SUPPLY SYSTEM FOR ELECTRIC RAILWAYS.

SPECIFICATION forming part of Letters Patent No. 600,101, dated March 1, 1898.

Application filed February 25, 1897. Serial No. 625,028. (No model.) Patented in England January 25, 1896, No. 1,843.

To all whom it may concern:

Be it known that we, DAVID URQUHART and FRANK WYNNE, subjects of the Queen of Great Britain and Ireland, residing in Westminster, London, England, have invented Improvements in Supply Systems for Electric Railways, of which the following is a specification.

The invention covered by this patent was patented to us January 25, 1896, No. 1,843, in Great Britain.

This invention has reference to improvements in that kind of means or apparatus for electrically propelling tramway and railway vehicles, including locomotives, (hereinafter called "cars,") in which the electrical energy required is generated at a fixed point or points and conducted to the moving vehicle by means of fixed main conductors and a series of suitably-insulated short contact-surfaces (hereinafter called "road-contacts") that are exposed in the roadway and are automatically connected by switch devices to one of the main conductors when the car covers or nearly covers them and are automatically disconnected from such main conductor when the car has passed them, the car being provided with a metallic or other conducting brush or brushes or with collecting-wheels or other suitable device (hereinafter called the "main brush") arranged to rub on the road-contacts and thus connect the driving-motor of the car (hereinafter called the "motor") to the said main conductor. Both main conductors may be insulated or only that one to which the road-contacts are temporarily connected, the other being uninsulated. In the latter case the rails on which the vehicle runs may be or form part of such uninsulated main conductor. When the rails are thus connected to or constitute one of the main conductors, the running wheels of the car may be used as the collector or contact between the motor and that main conductor, and when referring to such an uninsulated main conductor we shall hereinafter use the expression "earth."

In carrying out our invention we generally prefer to make the road-contacts about half the length of the car, so that the car and its extensions will about cover two road-contacts and the gap which separates them.

An object of the invention is to enable each of the said switches to be closed electrically without the winding of the electromagnet that operates the switch-lever being at any time placed in connection with the main conductor and consequently traversed by the main current passing to the motor, so that there shall be no liability of the switch being kept closed after the vehicle has passed the switch by leakage of electricity from the main conductor to a road-contact through the winding of the corresponding switch-magnet. For this purpose to each road-contact there is connected one coating of an electric condenser, the other coating of which is connected to earth. This condenser of suitable capacity may be placed in a suitable box or receptacle in the roadway. In connection with the switch for connecting the road-contact to the insulated main conductor there is provided an electromagnet so constructed and arranged that when energized by an electric current it will operate the magnet-armature and close the switch, and on the electromagnet ceasing to attract its armature the switch will open either by gravity or through the action of a spring, or both, or the opening of the switch may be assisted by another electromagnet, as described in the specification of Letters Patent No. 591,706, dated October 12, 1897. The first-mentioned electromagnet, which is preferably made with a laminated iron core, is inserted either between the condenser and the road-contact or between the condenser and earth, so that any current flowing in and out of the condenser must pass around its winding and energize it.

On the car to be propelled is an apparatus for producing alternating or intermittent currents of suitable frequency. This apparatus may be an alternating-current dynamo driven either by the motor or from a battery on the car, or it may be a Ruhmkorff coil provided with a make-and-break arrangement and worked from the main motor-circuit or from a battery, so as to produce an intermittent current, as well understood. This apparatus, whatever form it may take, is hereinafter called the "alternator." One terminal of the alternator is connected to the main brush and the other terminal to earth. Sometimes a choking-coil is placed in the connection between the main brush and the motor for a purpose hereinafter mentioned.

Figures 1 to 8, inclusive, of the accompany-

ing drawings are diagrammatic views showing various arrangements of current-supply apparatus according to this invention.

Referring to Fig. 1 of the drawings, 1 1 are the road-contacts, in the form of short rails arranged longitudinally in the roadway, and in connection with each of which there is provided an electromagnetically-operated switch for connecting the road-contact to the insulated main conductor 2 of electricity. Each switch comprises an electromagnet, the laminated core 3 of which has one end of its winding 4 connected to the corresponding road-contact and its other end to one coating 5 of a condenser, the other coating 5^a of which is connected to earth E, and a switch-lever 6, adapted to be attracted or moved into its closed position against the force of gravity, or of a spring, or of both, by the electromagnet 3 4 when the same is energized, and to then electrically connect together insulated contacts 7^a 8^a, that are in connection, respectively, with two conductors 7 8, connected the one with a road-contact and the other with the main conductor.

9 is the car to be propelled; 10, the car-motor, having its terminals connected, the one with a main brush 11, carried by the car, and the other with earth E′, through the metal frame of the car, car-wheels, and rails on which the car travels. 12 is an alternator arranged on the car and having one of its terminals connected to the main brush 11 and the other to earth E′, and 13 is a choking-coil placed in the connection $13^\times$, between the main brush and the car-motor. The main brush 11 is made sufficiently long to bridge each gap $1^\times$ between adjacent road-contacts 1. The alternator, which is of the kind hereinbefore described, may have, for example, a frequency of, say, about one thousand alternations per second. With this frequency each condenser 5 5^a, which may be constructed of tin-foil with paraffined paper insulation, may have a capacity of one microfarad. The choking-coil 13 may be of ordinary construction and wound to suit the frequency of the alternator.

As will be seen, the arrangement is such that when the main brush 11 rests on a road-contact 1 there will be two paths for the alternating current produced by the alternator 12—viz., one to the main brush 11, thence through the choking-coil 13 and motor 10 to earth E′ and back to the other terminal of the alternator, the other from the main brush to the road-contact, thence to the condenser 5 5^a, and from the condenser to earth and back to the alternator, passing in its course around the winding 4 of the electromagnet 3 4, which, as hereinbefore stated, may be placed between the condenser and earth instead of between the condenser and the road-contact. If the choking-coil 13 is suitably wound, nearly the whole of the alternator-current will traverse this second path and will thus energize the electromagnet 3 4 and actuate the switch-lever 6 in a direction to connect the corresponding road-contact 1 with the main conductor 2 through the leads 7 and 8.

To prevent or check the alternator-current passing to earth through the main conductor 2 and the generator 15 at the generating-station when any one of the switches is closed, a choking-coil 16 may be placed in the connection 7 8 between each road-contact and the main conductor.

The means hereinbefore described of actuating the switch of each road-contact may in some cases have combined therewith a holding-up device consisting either of a separate winding 7^b, as shown in Fig. 2, wound around the electromagnet-core 3, and through which the main current will flow when the switch is closed, or of a separate electromagnet comprising a winding 7^b and core 3^a, as shown in Fig. 3, the core 3 or 3^a in each case being energized by the main current and so arranged, as shown, as to hold up the armature or switch lever 6 and keep the switch closed so long as current is passing from the main conductor to the corresponding road-contact—that is to say, so long as the main brush 11 is on that road-contact and the car-circuit is complete.

We sometimes include in the alternator connection 12^a on the car, Figs. 1, 2, and 3, a high resistance having little or no induction—such, for example, as a series of incandescent electric lamps—so as to prevent any of the main continuous current that is passing to the brush 11 from being short-circuited through the alternator 12, or a condenser 17 may be inserted in the said alternator connection for a like purpose.

Fig. 4 is a diagrammatic view showing a modified arrangement in which a second brush 14 on the car is placed about one road-contact length in advance of the main brush 11, and the alternator 12 is connected to this advanced or switch brush instead of to the main brush. In this case the switch connections 7^a 8^a and leads 7 and 8 are so arranged that the road-contact which is by the action of the switch connected to the main conductor is not the road-contact 1 to which the condenser-coating 5 of the switch is connected, but the road-contact 1^a in rear of such road-contact 1. Thus so long as the switch-brush 14 bears on one road-contact the road-contact behind and on which the main brush 11 will then be bearing will be the one connected to the main conductor 2. The leads 7 and 8 may include a winding, such as 7^b in Figs. 2 and 3, to be traversed by the main current and hold the switch-lever 6 in its closed position so long as the main brush 11 is on the corresponding road-contact. This winding may be on the core 3 of the switch-magnet, as in Fig. 2, or, as shown in Fig. 3, on a separate core.

Fig. 5 shows diagrammatically another arrangement in which for actuating the switch a condenser is placed at each gap between the consecutive road-contacts, the coatings

5 5^a of the condenser being connected, respectively, to the two adjacent road-contacts 1, the electromagnet 3 4 for operating the switch-lever 6 being, as before, inserted in one or other of the two connections. In this case two brushes are placed on the car, one—viz., 11—being the main brush, connected both to the alternator 12 and to the car-motor 10, and the other or switch-brush 14 being connected to the alternator only. This switch-brush 14 is placed a road-contact length, or nearly a road-contact length, from the main brush 11 and in advance of it if the trailing road-contact 1^a of the pair is the one connected to the main conductor by the operation of the switch, as in the arrangement shown in Fig. 5, and in the rear of it if the leading road-contact of the pair be the one that is connected to the main conductor by the switch, as shown in Fig. 5^a. So long as the two brushes 11 14 rub on different bars there will be a completed condenser-circuit throught the alternator and condenser coatings and the switch will be actuated. In these two arrangements we prefer, as shown, to use a holding-up device, such as the electromagnet 3^a 7^b for the switch-lever 6, as otherwise the switch will open whenever the two brushes are on the same road-contact and also when the main brush is bridging a gap $1^\times$ between adjacent road-contacts unless a choking-coil 13^a is inserted between the main brush and alternator, as shown in Fig. 5^a, to prevent this action taking place. In this arrangement it is advantageous to make the road-contacts 1 only about one-third the length of the car, as at the moment that the main brush 11 bridges a gap $1^\times$ three road-contacts will be electrically connected to the main conductor 2. The appropriate length of the road-contacts will depend on the distance which separates the switch-brush and the main brush. When the distance apart of the brushes is less than the length of each road-contact, a choking-coil 13^a is placed in the alternator-circuit on the car to prevent the alternator being short-circuited when the two brushes make connection with the same road-contact. This choking-coil must be so designed as to allow the current required to energize the switch-magnet to pass, but to choke back any larger current.

When a holding-up electromagnet 3^a 7^b is used in this arrangement, the switch-brush 14 may be placed sufficiently far from the main brush to prevent them from being simultaneously upon the same road-contact. In this case the choking-coil 13^a can be dispensed with.

We prefer to so construct the alternator that it will yield a constant current—that is to say, so that the current produced will not materially increase with reduction of the resistance of the condenser-circuit.

Fig. 6 shows, diagrammatically, a modified arrangement in which there are provided on the car two alternators 12 12^A, so driven as to be always in step, and four brushes 11 11^a and 14 14^a, none of which is long enough to bridge the gaps 1^* between the adjacent road-contacts. Taking these brushes in their order, the first or forward one 14 is a switch-brush connected to one terminal of the alternator 12. The second brush 11 acts both as a switch-brush and a main brush, being connected to one terminal of the alternator 12^A and to one terminal of the car-motor 10, a choking-coil 13 being inserted in the latter connection. The third brush 14^a is a switch-brush, being connected to the second terminal of the alternator 12, and the fourth brush 11^a is both a switch and a main brush, being connected both to the second terminal of the alternator 12^A and to the motor 10. The distance between these brushes is such relatively to the length of the road-contacts that the circuit of the alternator 12 is completed to a forward condenser 5 5^a through a forward road-contact 1 before the circuit of alternator 12^A is broken by the fourth brush 11^a, leaving the rearward road-contact 1^b. There are thus at times three road-contacts—viz., 1 1^a 1^b—having brushes bearing on them, and two of these—viz., 1^a and 1^b—are connected to the main conductor 2.

Fig. 7 shows a modification of the last-described arrangement, wherein the first and second brushes 14 and 11 are both switch and main brushes and the brushes 14^a and 11^a switch-brushes only. With this arrangement the choking-coil 13, Fig. 6, can be dispensed with, the construction and operation in other respects being similar to the arrangement shown in Fig. 6.

Fig. 8 shows a modification of the two last-described arrangements, wherein the condenser 5 5^a at each gap $1^\times$ is used to effect the operation of the switch at the road-contact 1^b behind the two road-contacts 1 1^a, which are connected to that condenser, this being effected by taking a separate insulated lead 7^c back from each condenser to the switch in the road-box behind. In this case the four brushes 14, 11, 14^a, and 11^a all become switch-brushes, not being connected to the car-motor in any way, and a fifth brush 11^b, which is the main brush, is placed on the car behind the four switch-brushes.

We have described the principal methods we employ for actuating the road switches; but these methods may be modified in various ways, and where we have described the connections with reference to the motion of the car in one direction it is evident that the connections will either equally apply for motion of the car in the other direction, or that by the introduction of switches on the car the connections can, as well understood, be altered to suit motion in the other direction.

We have also described our methods as applied to cars using the rails as part of the return-circuit, but they are equally applicable in cases where the return connection is made by means of additional road-contacts, in which

case the electromagnet corresponding to each main road-contact may be made to simultaneously actuate the switches of both the main and return road-contacts.

What we claim is—

1. In apparatus for supplying electricity to electrically-propelled vehicles, the combination with road-contacts, a main conductor, and switches for successively connecting said road-contacts to said main conductor, of condensers, switch-operating electromagnetic devices having their windings arranged in the condenser-circuits, and an alternator adapted as a vehicle to be be propelled travels along to have its circuit completed through the successive condenser-circuits so as to thereby close the corresponding switches.

2. In apparatus for supplying electricity to electrically-propelled vehicles, the combination with switches for connecting a main conductor with successive road-contacts, of electromagnetic switch-operating devices each having its winding in connection with a condenser, and a traveling alternator adapted to complete the circuit of the successive electromagnetic devices through the corresponding condensers.

3. In apparatus for supplying electricity to electrically-propelled vehicles, the combination with road-contacts, a main conductor and switches for connecting each road-contact with said main conductor, electromagnets each adapted when excited to close one of said switches, condenser-circuits connected to said road-contacts and each including a condenser and the winding of one of said electromagnets, and a traveling alternator adapted to complete the successive condenser-circuits through the road-contacts.

4. In apparatus for supplying electricity to electrically-propelled vehicles, the combination with road-contacts, a main conductor, and switches for successively connecting said road-contacts to said main conductor, of condensers each having one of its coatings connected to a road-contact and its other coating with earth switch-operating electromagnets each having its winding arranged in the circuit of one of said condensers and a traveling alternator having one terminal adapted to be connected with the successive road-contacts and the other terminal with earth.

5. In apparatus for supplying electricity to electrically-propelled vehicles, the combination with road-contacts, a main conductor, and switches for successively connecting said road-contacts to said main conductor, of condensers each having one of its coatings connected to a road-contact and its other coating with earth, switch-operating electromagnets each having its winding arranged in the circuit of one of said condensers, a traveling motor having its terminals connected respectively with a brush adapted to bridge and connect successive road-contacts and with earth, a traveling alternator having one of its terminals connected to said brush and its other terminal with earth, and a choking-coil arranged in the circuit between said brush and motor.

6. In apparatus for supplying electricity to electrically-propelled vehicles, the combination with insulated road-contacts, a main conductor, switches each adapted to close a circuit between a road-contact and the main conductor, a choking-coil arranged in each such circuit, condensers each connected to a road-contact and with earth, switch-operating electromagnets each having its winding in series with one of said condensers, and a traveling alternator having one terminal adapted to be connected with the successive road-contacts and the other terminal with earth.

7. In apparatus for supplying electricity to electrically-propelled vehicles, the combination with road-contacts, a main conductor, switches for successively connecting said road-contacts with said main conductor, condensers, electromagnetic devices adapted to operate said switches and having their windings arranged in the condenser-circuits an alternator adapted as a vehicle to be electrically propelled travels along to have its circuit completed through successive condenser-circuits, and switch-holding-up devices each having its winding adapted to be placed in the main or motor circuit by the closing of one of said switches.

8. In apparatus for supplying electricity to electrically-propelled vehicles, the combination of road-contacts 1^a main conductors 2, pairs of conductors 7 and 8 between said main conductor and each road-contact, switch-levers 6 each adapted when closed to connect the corresponding pairs of conductors 7 and 8, condensers 5, 5^a each in connection with a road-contact and with earth, switch-operating electromagnets 3 4, each having its winding 3 in one of the condenser-circuits and a traveling alternator 12 having one terminal connected to a brush adapted to travel upon the road-contacts and its other terminal connected to earth, substantially as described for the purpose specified.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

DAVID URQUHART.
FRANK WYNNE.

Witnesses:
PERCY E. MATTOCKS,
EDMUND S. SNEWIN.